CASE STUDY TERRA ALTA SKY LOUNGE MEMBRANE STRUCTURE IN EL SALVADOR CENTRAL AMERICA

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Key Words: Central America, Tensile Membranes, Guatemala, Development, History

Summary: *This document is about a project developed with unique circumstances around it. Such as altitude, wind current and the adaptation to an existent and occupied building which was not prepared for a tensile structure from its original layout. It also includes examples of other projects developed by our firm threw out Central America that have become unique mainly due to its function ,design and use of color.*

INTRODUCTION

Tensile membrane structures are often built on the ground or within solid surroundings that can bring enough counterbalances to the tensioned system through foundations, lateral anchors or connections to other building systems.

However, when a membrane structure must be installed 17 stories above ground, the membrane is already cut and welded ready for installation and there is not enough resistance on the flagstone in which the tensile structure is going to be installed the project itself is in danger of not becoming a reality at all. The membrane structure built at the sky lounge of the Terra Alta building in El Salvador, Central America, was nothing short of a real challenge.

Besides the challenge itself, or the elements considered normal in any other project, there were many other factors that needed to be taking into account:

- From the contractor's perspective: the project´s profit margin, analysis of the flagstone with the building´s structural designer and contractor, architectural form and new elements, and finally an agreed general layout between the parties involved

- From the client´s perspective: the designated budget, delays, and structural interventions to its property and tenant control since the apartment complex was at the time already fully operational.

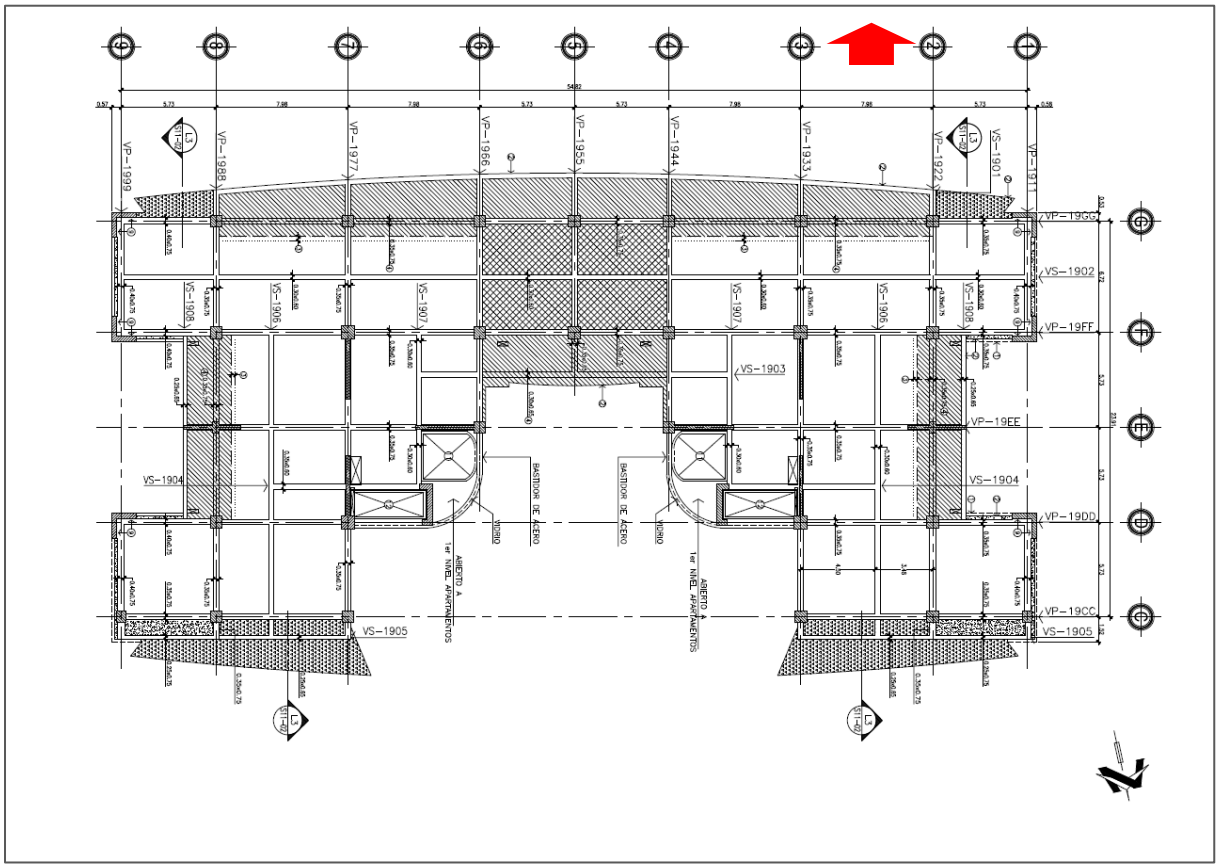
1. REQUIREMENTS FOR THE DESIGN

The flagstone on the 17th floor was design as a final terrace, not to be occupied nor used except for the sole purpose of maintenance. However due to the increasing need of social areas in projects of such nature, the 17th floor was then re-designed to hold a social lounge for the buildings tenants.

It included a wooden deck to be constructed above steel frames with rubber bases and what it's known as a pergola. A pergola is an arbor, constructed of vertical posts or pillars that usually support cross-beams and a sturdy open lattice, often upon which woody vines are trained. It served as a sort of protection for the open terrace.

The membrane proposed was serge ferrari pre contraint 902

The design, lacked originality and the element of surprise, astonishment, beauty and rhythm that only a tensile structure can provide.

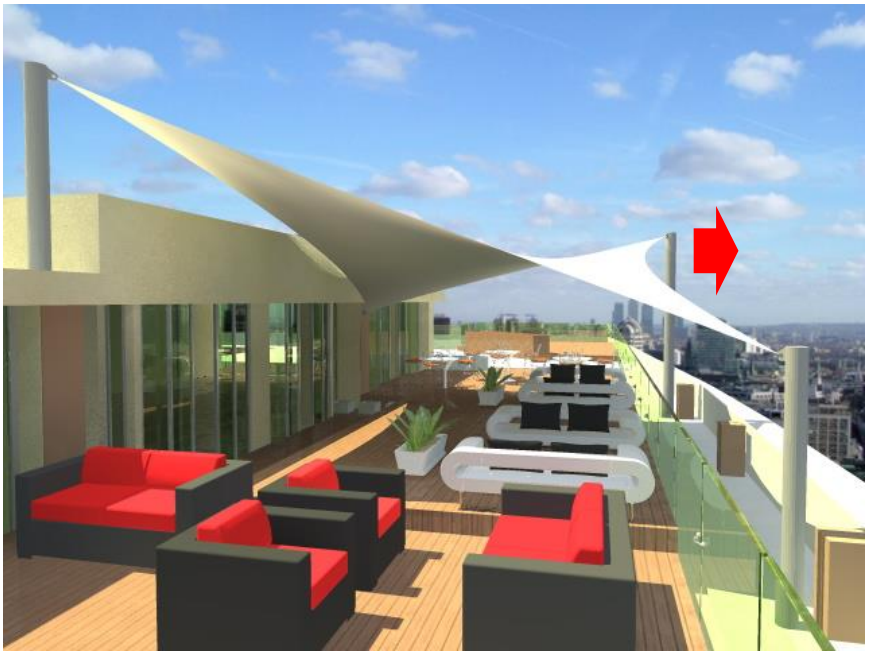


The building as a residential development exploited one of its main features, its view. To the south, it shows an open view of the clear San Salvador´s sky, a lot closer it shows the magnificent view of El Salvador's main elite golf course, Cuscatlán golf club.

2. MEMBRANE ORIGINAL DESIGN

When tensile architecture alternative became into play as a serious alternative, it was clear that the design had to be developed around that single element, the view. The cover was then, conceived as a 100 square meters four point's ridges and valleys membrane, three of which were masts, and a fourth point anchored to a concrete column. Of the three masts, one was higher.

Another key element that had to be complied with was the geometry of the membrane due to the location of supports within the flagstone, which ultimately was the main challenge in this project.



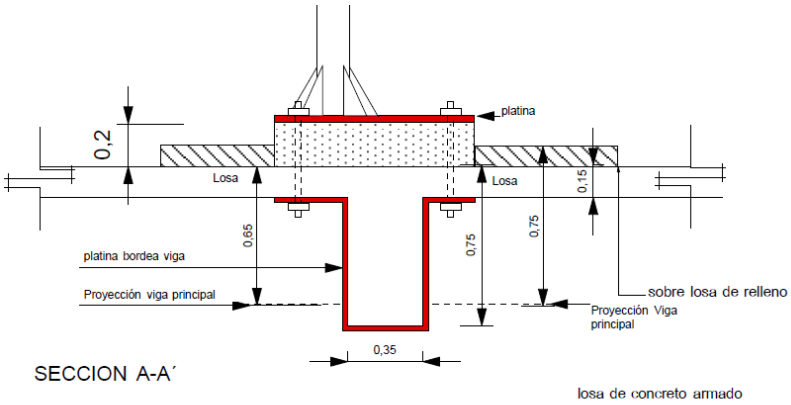
3. STRUCTURAL DESIGN AND CONSIDERATIONS

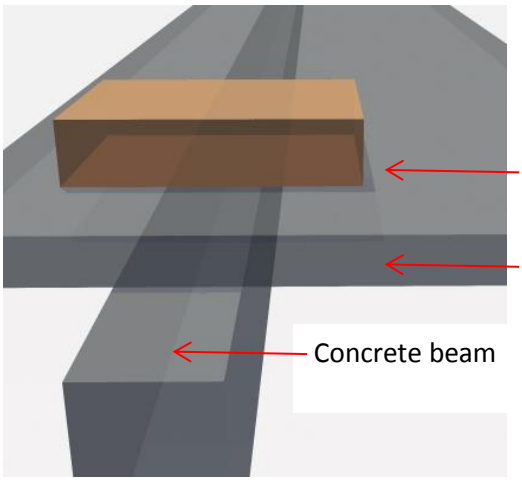
The structural conditions of the building were not appropriate for the implementation of a tensile membrane. The challenge was to figure out how to accomplish the right design and the right function. The flagstone was too weak for the load required, mainly because:

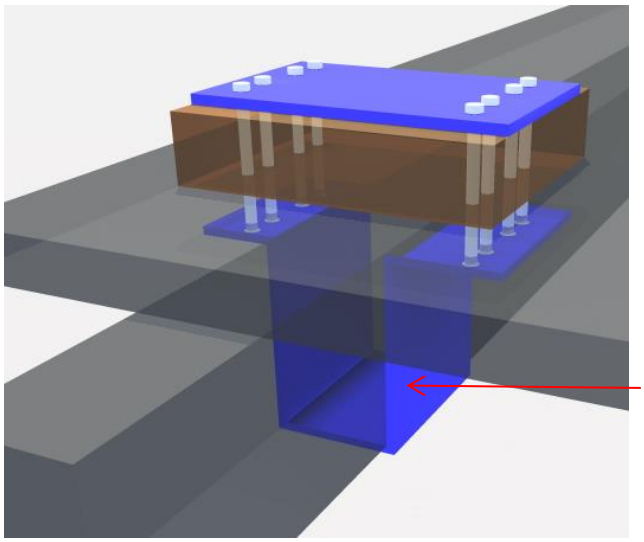
- Height of the masts
- Momentum at the base
- Concrete section of the flagstone

- Site´s strong wind currents

Since 15 cm of the top of the flagstone was just a filling. **Step 1** of the solution conceived was to build a double "foundation".to increase the structural section of the base with new and more resistance concrete.





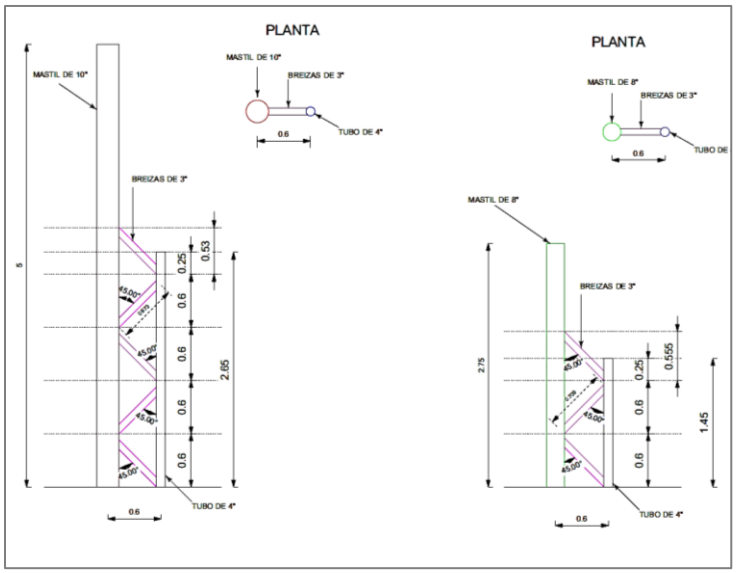


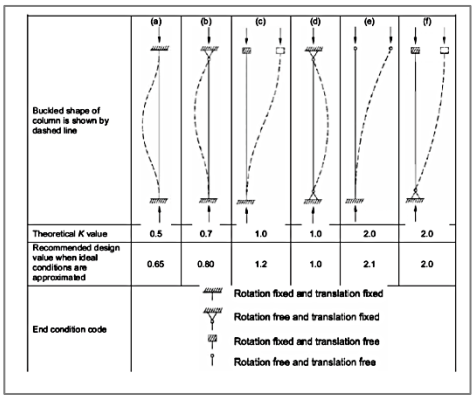
Step 2 Was to place one inch thick steel plates above and under the flagstone and dew structural concrete filling with structural 1 meter long steel bolts through the whole section. However, the geometry of the membrane caused the bases to coincide with the structural concrete beams of the building, making it impossible to perforate.

Therefore, the concrete beams needed to be avoided so additional 1 inch steel plates were placed.

Step 3 After the proper placement of the steel

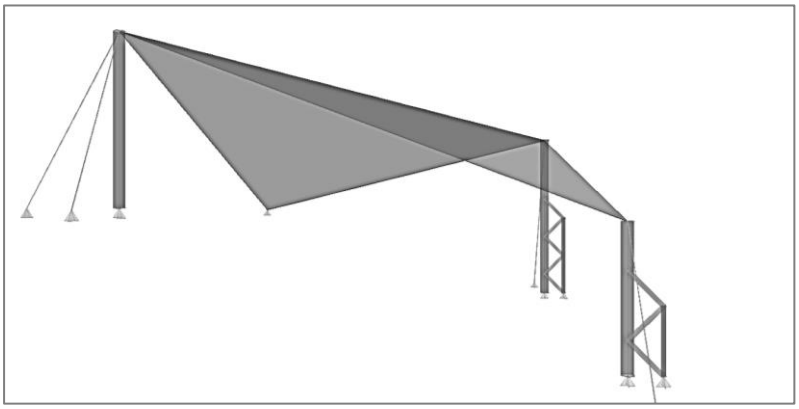
plates, steel joist like elements were design in the lower part beside each of the two main masts to counter balance the great momentum at the base caused by the height and weight of the structure itself and the wind load on the membrane system.





The joists designed needed to take into consideration not only solving the structural problem itself but also the architectural criteria in not creating an element that could obstruct the view. The height of the wooden deck contributed to this factor.

Step 4 There wasn't enough horizontal space for the steel cables that help counter rest the membrane load, similar steps as the reinforcement of the flagstone were taken.

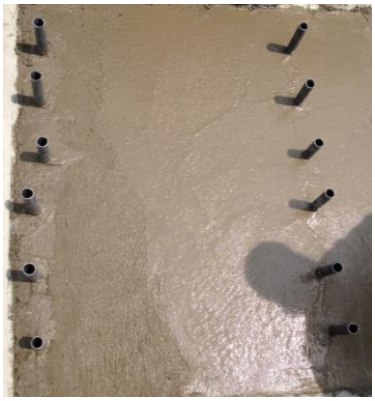


4. EXECUTION

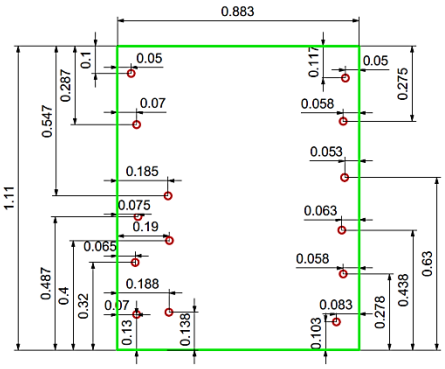
Once the design and general layout for the project was fully developed, a detailed execution program was set into motion, considering a key factor, the building was fully occupied and the social area, on which the membrane was to be erected, was also fully operational, making the window schedule narrower

A. The poor concrete filing was removed, and the perforations for the later placement of the steel bolts were made. Note that the perforations are not completely aligned due to the asymmetrical steel reinforcement of the flagstone

B. Before the new concrete was poured we used SIKADUR 32 as an adherent bridge for the older and newer concrete. The diameter of each hole was rehearsed and pvc tubes were put into place, assuring the smooth later placement of the 1m long steel bolts.



C. After the concrete had dried, a stencil was drawn for the exact dimensions and perforations of the steel plates. The steel plates where then cut and perforated, and later where put in their right place above and beneath the flagstone. The steel bolts where

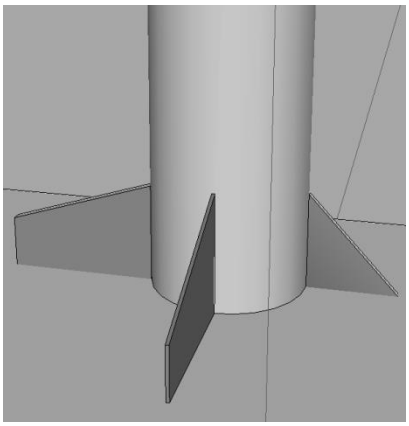


also placed and sealed to avoid corrosion and water penetration



D. The joist elements where welded to the two main masts. And additional bracings where also placed at the base of each mast





5. PROJECT FINALIZED